PAVEMENT MANAGEMENT AND PAVEMENT DESIGN MANUAL



NOVEMBER 1998

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Section 1 — Pavement Management

Pavement Management

Introduction

A pavement management system is defined as a set of tools or methods that assist decision makers in finding cost effective strategies for maintaining the state roadway system in a serviceable condition. The detailed structure of a pavement management system is separated into two levels; system (network), and project level. Network level management is where administrative decisions are made that affect the programs for the entire roadway system. The management system considers the needs of the network as a whole and provides information for a statewide program of new construction, maintenance, and rehabilitation. The goal of this level is to optimize the use of funds over the entire system. The managers at this level compare the benefits and costs for several alternative programs and then identify the program/budget that will have the greatest benefit/cost ratio over the analysis period.

Project level pavement management is where technical decisions are made for specific projects. At this level detailed consideration is given to alternative design, construction, maintenance and rehabilitation activities for specific projects. This is accomplished by comparing benefit/cost ratios of several design alternatives and picking the design alternative that provides the desired benefits for the least total cost over the projected life of the project. Since system level analysis provides target maintenance, rehabilitation and reconstruction treatments and costs, it is necessary for the project level management system to provide additional information before designs are finalized.

Pavement Management Process

System Level

The system level pavement management in UDOT is referred to as the program level. This is housed primarily in the Pavement Management Unit within the Program Development Group, but depends on consultation and participation from the Region Pavement Management Teams. The system level analysis consists of evaluating pavement data to enable the selection of candidate projects, project scheduling and budget estimates.

The System Level Pavement Management Process

The products of system level pavement management include:

- Lists of recommended candidate projects
- Reports on the current state of the highway network
- Recommended budget levels to meet system level goals and strategies.

A number of separate activities help to produce these products.

1. Network Definition

A pavement management system can be set up for any number of highway networks. Examples can include all state roads, state roads on the National Highway System, Federal-Aid Eligible roads within an urbanized area, city streets, and concrete roads. The first step in the creation of a pavement management system is to define which set of roads will be analyzed.

2. Definition of Analysis Sections

Once the network is defined it must be divided into analysis sections that are mutually exclusive; homogeneous (as far as possible) in terms of age, pavement type, and pavement condition, and of appropriate length for an improvement project. The input of the Region Pavement Management Team becomes very important. Region staff are the best equipped to make meaningful recommendations as to how a network should be divided.

3. Data Collection

Three types of data are important to the pavement management system:

- *Construction history data* provides the age, surfacing thicknesses, and surfacing types for all sections. This data is generally best available at the Region level. Good age data is essential to the performance of computerized pavement management models which generally rely on age as the basis for performance prediction curves.
- *Inventory data* is information about the roads that generally remains static over time. Data items include pavement type, number of lanes, width, functional classification, and administrative items. This data is kept current by the Planning Statistics Unit.
- Condition data includes systematically collected pavement condition data, as well as traffic data. The Planning Statistics Unit collects on predetermined cycles such items as traffic, pavement roughness, rut depth, skid number, cracking, weathering, bleeding, structural strength (FWD), and faulting. This data is reported on one-mile sections, and must be summarized to the analysis sections defined in step 2.

4. Evaluations of Current Conditions and Trends

Based on the condition data provided by the Planning Statistics Unit, reports can be produced to show the current state of the network. The current year's condition can be compared with conditions in previous years to show trends. These trends can help managers determine the effectiveness of the overall pavement management strategies.

5. Pavement Management Model Creation

System level pavement management includes the creation and maintenance of computerized models which can predict future network condition, recommend candidate projects based on given budgets, and predict future condition of individual pavement sections. The creation of these models requires many basic parameters to be defined.

- A. Condition indices are created to measure aspects of the pavement condition, trigger treatments, and report overall network health.
- B. Performance curves are created for each of the condition indices. They predict how a pavement will behave over time. There can be as few as one performance curve for each condition index, or as many as one performance curve for each combination of condition index and analysis section.
- C. A list of Treatment Alternatives must be developed. For each treatment to be considered, a cost needs to be defined, the impact of the treatment on each of the condition indices needs to be defined, and a "trigger zone" needs to be defined. A "trigger zone" is the set of conditions as defined by the condition indices, the performance curves, and any other pertinent data items under which a particular treatment would be feasible. Once the treatment alternatives, the performance curves, and the condition indices are defined, the pavement management model can generate a list of "strategies." A "strategy" is a major treatment in a particular year, possibly combined with a secondary treatment in a later year and also combined possibly with preventive maintenance and reactive maintenance treatments. Each strategy has an associated present value cost and a present value benefit. The benefit is measured by the impact of each of the treatments contained in the strategy on the performance curve used for the calculation of benefits.
- D. Budget Scenarios define for the model the amount of money that can be spent in any particular year of the analysis. The model uses the allocated money to "optimize" the network. That is, a single strategy is selected for each of the analysis sections based on the overall benefit to the network as a whole and on the available money.

All of the model parameters require the input of those people in UDOT most qualified to describe pavement performance, treatment, definitions, and impacts. These people include, but need not be limited to, the Region Pavement Management Engineers (Region Materials), and the Pavement Management Engineer (Program Development).

6. System Recommendations

The output from the pavement management model is a list of candidate projects based on the input parameters, the input condition data, and the input budget. These candidate projects can be provided to the Region Pavement Management Teams as an additional input in the preparation of their STIP recommendations. The Regions and Central Maintenance also provide feedback to the model. The candidate projects recommended by the model may match closely with the Teams' recommendations or the match may not be good at all. In either event, the model needs continual updating and improvement in the form of adjustments to the performance curves, updated treatment costs, and changes in the condition indices.

In addition to the list of recommended candidate projects, recommendations can be made as to overall funding levels required to meet the pavement preservation goals of the Department. This is done by running the model with a variety of budget scenarios.

An ongoing commitment on the part of all who work together to create the pavement management system ensures its success.

Project Level

Project level pavement management is the level at which technical management decisions are made for specific projects or pavement sections. Project level analysis is the evaluation of a pavement section to select the type and timing of rehabilitation and/or maintenance. Project level pavement management is shared between staff and line management in the Department. Line management is housed in the Regions with the responsibility being in the Region Materials section. These duties are specifically assigned to the Region Pavement Management Engineer. The Regions develop the strategies, plans, and designs for pavement improvements in conformance with department standards. Staff level responsibilities for pavement management and design are in the Pavement Management Section of the UDOT Program Development Division. The Pavement Management Section helps develop standards and provides technical review and support to the regions.

Project Level Pavement Management Guidelines

In this area emphasis is placed on the efficient use of available pavement management data. A condition based evaluation is separated into two project areas. Projects exhibiting simple surface distress undergo only initial screening. This is a matching of distresses and treatments with

possible projects. Projects with complex conditions are identified by the initial screening process and then further evaluated in a detailed analysis. The detailed analysis explores both surface distress and non-distress characteristics to generate recommendations about the scope of work. These may include traffic loadings, accident rates, deterioration rates, traffic volumes, and pavement age. The results of these analyses support the future work of life-cycle cost analysis, STIP development, and program optimization.

One of the primary objectives of project level pavement management is to generate a STIP list for the three and five year programs. The following are the five steps that should be used in this process.

- 1 Condition Assessment
- 2 Project Determination
- 3 Treatment Recommendation
- 4 Cost Estimation
- 5 Project Priority Ranking

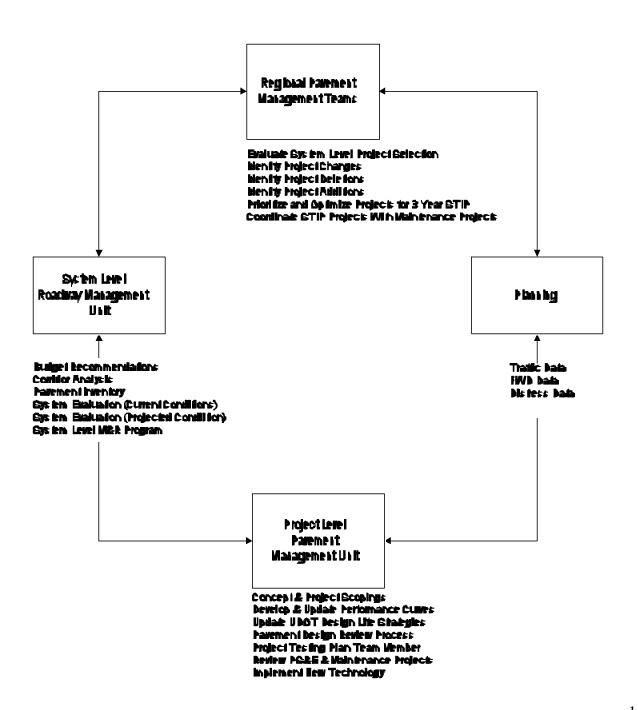
All projects are subject to an initial screening; which matches pavement condition to appropriate treatments or treatment classes. This generates an itemized list of treatments to address the existing distresses. A preliminary classification based on these results identifies each project in terms of its scope of work as follows:

- 1 Do Nothing
- 2 Preventative
- 3 Corrective
- 4 Rehabilitative
- 5 Reconstructive

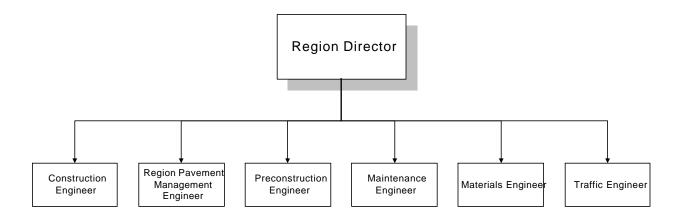
Once the recommended scope of work is identified, alternatives can be generated. The process and procedures for developing the alternatives are outlined in the additional sections of this manual. The Appendix of this section contains flow charts that outline the various procedures and job duties of the various personnel.

Appendix 1

UDDT PAVEMENT MANAGEMENT INTERACTION



REGIONAL PAVEMENT MANAGEMENT TEAM

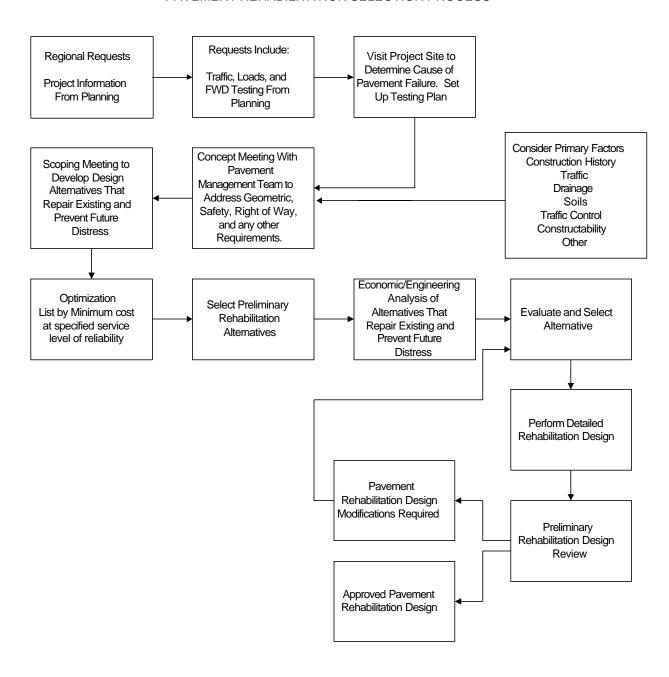


Region Pavement Management Engineer's Responsibilities

Region Pavement Management Engineer

Perform Pavement Designs
Perform Pavement Approval
Identify Regional Projects
Strategy Selection Performance
Project & System Level Pavement Management Feedback
Collect Current Construction History Through Project Close-Out
Collect Additional Project or Distress Information for Central
Perform FWD Deflection Basin Analysis For Rehabilitation Projects
Back Calculate Layer Moduli For Pavement Sections To Be Rehabilitated
Review PS&E Plans

PAVEMENT REHABILITATION SELECTION PROCESS



Section 2 — Coordination of Project Pavement Design

Coordination of Project Pavement Designs

Introduction

The need for a specified timetable and program for planning, creating, submitting, and reviewing a project pavement design stems from the need to accurately and efficiently complete the activity according to the Department's 08-1 process (PPMS). This process uses standard project programming techniques to schedule and organize a project through the design phase. In-depth pavement designs can require up to eight months to complete due to the implementation of soils investigations, traffic investigations, field and laboratory testing of the existing pavement, review and modification of the project scope, and review and selection of the appropriate alternatives. The timetable outlined in this section is intended to delineate a process that has been accepted by the UDOT Materials Division that will coordinate the actions of all the parties involved in completing the pavement design in a timely manner and with a minimal amount of confusion.

08-1 Process (PPMS)

The 08-1 process is a planning and scheduling tool used by the Preconstruction Division to organize the design of all state projects. The process includes the division of any particular project into a large assortment of relatively small activities. Each activity is defined by the work it encompasses, the time frame expected to complete the project, the responsible parties, and a list of those who should receive copies of the final document (if necessary). The design of a pavement structure requires the completion of two separate activities with the PPMS system. The first activity is Pavement Verification (activity 25C) which entails the investigation and summarization of the existing pavement structure. Part of the output of the activity is a report that combines the existing pavement condition with the project scope into a preliminary recommendation for the type of rehabilitation of the pavement structure that is appropriate. The recommendations are preliminary and based on the experience and knowledge of the engineer performing the review, and are not considered to be cast in stone. The recommendations can be modified during the future portions of the pavement design process.

The second activity is Pavement Design (activity 28D) which entails the actual in-depth study of the pavement condition and development of the appropriate rehabilitation strategy to be applied within the project. The design is considered an extension of the pavement verification process although the final pavement design document is considerably more involved than that of the pavement verification. The design is completed through the designer then reviewed for approval at the region level with input from the state level. The approved document is a requirement for inclusion in the Design Study Report submitted by the Roadway Design Engineer.

Pavement Design Coordination

The coordination process outlined within this section is based on the requirements outlined in the Pavement Design Activity description, however, its requirements are considerably more detailed. The requirements are set for all designs, regardless of size, cost, time frame, or location. During preliminary discussions of the pavement design approach, the Region Pavement Management Engineer will decide if any of the requirements are superfluous and can be passed over.

Time Line

Development of a UDOT pavement design for a roadway section includes the review and discussion of project concepts and scopes and the development of a pavement testing strategy to determine the best approach for analyzing the pavement design problem. When the requirements for document review are included in the process, the time frame required for development and approval of a design can be as long as eight to ten months. This length of time must be taken into account when determining when to begin performing the design and when to anticipate the completion/approval of the document. Project protocol requires that the pavement design be approved before the Design Study Report (DSR) can be submitted. Reducing the time allotted for review, revision, and approval by the Region Pavement Management Engineer is generally not possible. Documents that are submitted for review with less than the allotted time allowed will invariably result in delays in the project design schedule.

The following list of project milestones should be reviewed and noted by the Pavement Design Engineer. The Pavement Design Engineer is responsible for initiating all phases that are his/her responsibility. Meetings will be held at the office of the Region Pavement Management Engineer. For clarification, the engineer responsible for performing the design of the pavement is referred to as the Pavement Design Engineer.

I. Project Concept Meeting

Activity 35C

Attendees: Defined within Act. 35C Outline

Output: Concept of overall project and requirements of pavement rehabilitation.

II. Pavement Design Concept Meeting

Attendees: Region Pavement Management Engineer, , Pavement Design Engineer. Output: Review of Project Concept and preliminary discussion of Pavement Design

Approach

Time Requirements: ½ hour, may be performed through a conference call.

III. Performance of 25C

Responsibility of Pavement Design Engineer.

Defined By Act. 25C outline, intended to be a cursory review of the project to gather information to be used for determining a proper testing plan.

IV. Pavement Design Testing Approach Meeting

Attendees: Region Pavement Management Engineer, Pavement Design Engineer Output: Review of Pavement verification information. Determination of testing strategy for the pavement, including type, location, level of detail of tests to be included.

Time Requirements: 2 Hours, must be done in person.

V. Performance/organization of Pavement Testing

Responsibility of Pavement Design Engineer.

Time Requirements: 1 to 3 Months

VI. Pavement Design Testing Review Meeting

Attendees: Region Pavement Management Engineer, Pavement Design Engineer

Output: Review of Pavement Testing information. Determination of design strategy for the pavement, including discussion of possible alternatives to be included.

Time Requirements: 2-4 Hours, must be done in person.

VII. Performance of Pavement Design

Responsibility of the Pavement Design Engineer

Time Requirements: 1 to 3 Months

Should be performed according to procedures in this manual

VIII. Preliminary Pavement Design Document Review Meeting

Attendees: Region Pavement Management Engineer, (if warranted), Pavement Design Engineer

Output: Preliminary Review of Pavement Design Document. A copy of the draft Pavement Design document should be submitted to the Region Pavement Management Engineer and the a minimum of 2 weeks before the meeting for review.

Time Requirements: 2 Hours, must be done in person

IX. Revision of Pavement Design Document

Responsibility of Pavement Design Engineer

Time Requirements: 2-4 weeks

X. Submission of Design Document for Review by Region Pavement Management Engineer

Responsibility of the Pavement Design Engineer

Submit 2 copies; one for Region Pavement Management Engineer. If the pavement design is done by the Region Pavement Management Engineer, it will be reviewed by the Region Materials Engineer for his concurrence. Pavement designs may be forwarded to the

Pavement Management Unit in UDOT's Planning Division for their consultation. *Time Requirements:* 2 weeks.

XI. Pavement Design Approval

Responsibility of the Region Pavement Management Engineer

The Region Pavement Management Engineer will approve all pavement designs. If the pavement design is done by the Region Pavement Management Engineer, this approval will be only after getting concurrence from the Region Materials Engineer. FHWA will get a copy of non-stewardship project pavement designs after they are approved by the Region Pavement Management Engineer. A periodic process review of pavement designs will be conducted by the Pavement Management unit in UDOT's Planning Division.

Draft copies of documents should be submitted for discussion during all progress meetings. The draft documents should be on plain 8.5 x 11 paper, printed in black and white.

Document Format

Final documents should be submitted directly to the Region Pavement Management Engineer and must include at least two identical copies. Specific format and content information is in section 3G for new designs and section 4 for rehabilitation designs. The general format requirements for the documents are as follows:

Pavement Verification Document (2 copies)

- 8.5 x 11 paper
- stapled or bound
- color documents should be legible when copied to black and white
- should include the UDOT project number on transmittal sheet and title sheet of document

Draft Pavement Design Document (1 copy)

- 8.5 x 11 paper (except for plan sheets included)
- stapled or bound
- color documents should be legible when copied to black and white
- should include the UDOT project number on transmittal sheet and title sheet of document
- document does not have to be fully formatted, but should include the entire expected text content of the final document.

Pavement Design Document (2 copies)

- 8.5 x 11 paper (except for plan sheets included)
- stapled or bound
- color documents should be legible when copied to black and white
- should include the UDOT project number on transmittal sheet and title sheet of document

document should be fully formatted

Acceptable References

There are a variety of references and software programs that are available for aiding in performing a pavement design. Acceptable references for use in performing pavement analysis and design include most materials that are based on the AASHTO design process.

Acceptable UDOT References:

DARWin Software
AASHTO Pavement Design Manual
UDOT Materials Manual of Instruction
ACPA Pavement Analysis Software
Statistical Traffic Sheets from UDOT Planning

Use of additional/optional AASHTO based design references are acceptable, however the material should be submitted to the Region Pavement Management Engineer for approval before use. Any non-AASHTO based materials will not be accepted.

Pavement Management

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The products of system level pavement management include:

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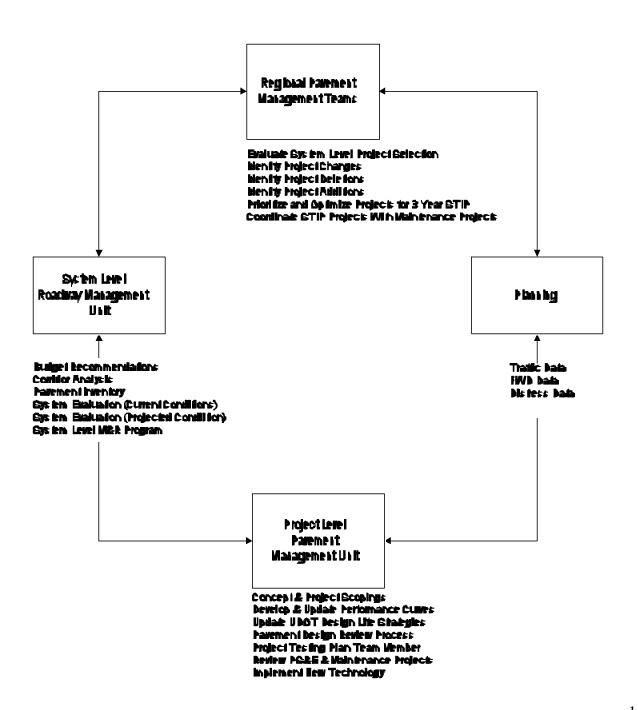
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- 3 Corrective
- 4 Rehabilitative
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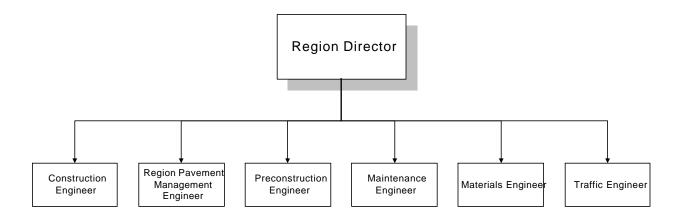
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UDDT PAVEMENT MANAGEMENT INTERACTION



REGIONAL PAVEMENT MANAGEMENT TEAM



Region Pavement Management Engineer's Responsibilities

Region Pavement Management Engineer

Perform Pavement Designs
Perform Pavement Approval
Identify Regional Projects
Strategy Selection Performance
Project & System Level Pavement Management Feedback
Collect Current Construction History Through Project Close-Out
Collect Additional Project or Distress Information for Central
Perform FWD Deflection Basin Analysis For Rehabilitation Projects
Back Calculate Layer Moduli For Pavement Sections To Be Rehabilitated
Review PS&E Plans

PAVEMENT REHABILITATION SELECTION PROCESS

